

ANNUAL REPORT

1961

CITY OF STRATFORD

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STRATFORD SEWAGE TREATMENT PLANT

PROJECT No. 57-S-2

OPERATED FOR

THE CITY OF STRATFORD

by

THE ONTARIO WATER RESOURCES COMMISSION

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Prepared by the
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GENERAL

The Activated Sludge Treatment Plant in Stratford was completed and put into operation in August of 1930. Treatment consisted of screening, aeration and final sedimentation. The sludge produced was stored in sludge storage beds. It was pumped from these beds to trucks from which it was spread on farm land.

The design capacity of the plant was only 2.5 m.g.d. and as a result in June, 1958 the plant was extended. The aeration section of the old plant was retained and the old final sedimentation tanks were converted to aeration tanks. Four primary and two secondary clarifiers were added as well as grit removal equipment and a digester.

The new plant is designed to treat a normal dry weather flow of 4 m.g.d. and flows up to 8 m.g.d. for short periods. Primary treatment alone can be given to sewage up to a flow rate of 16 m.g.d.

DESIGN DATA

The new 4 m.g.d. sewage treatment plant was designed by Canadian-British Engineering Consultants, Toronto. Schwenger Construction Company Limited of Hamilton were the main contractors on this project. Cost of the new plant was \$927,382.

(1) Inlet Works:

On entering the plant site the two concrete inlet sewers 30" and 48" dia. discharge into a channel which conveys the sewage flow to the screening chamber inside the machinery house. This

channel is fitted with a storm overflow weir over which all flows in excess of 16 m.g.d. are taken direct to the head of the effluent outfall pipe and so to the Avon River.

(2) Screening:

The screening chamber is divided into two parallel channels in one of which is installed a "Barminutor" or bar screen having 1" spacing between bars and provided with a cutting device which macerates any material retained on the screen. This is designed for flows up to 12 m.g.d., but is capable of passing flows up to 16 m.g.d. for short periods.

The second channel is of the same dimensions as the first and functions mainly as a by-pass should it be necessary at any time to close the first channel for maintenance. It is fitted with a bar screen which is cleaned by hand rake when necessary. Either channel may be closed off by two handstops.

Provision is made for the installation of a second "Barminutor" mechanism in the second channel in the future when flows of over 12 m.g.d. occur frequently. When this is done the two channels would normally both be in use in parallel.

(3) Detritus Removal:

After screening, the flow passes to a Dorr Detritor which consists of a grit settling tank with a collecting mechanism and a grit cleaning mechanism.

The settling tank is of a sufficient capacity to settle out 90% of grit coarser than 65 mesh when receiving the maximum flow of 16 m.g.d. At lower flows some organic matter will also settle. The grit, after being collected by the mechanism in-

to a side hopper, must, therefore, be freed from this organic matter. This is done by a cleaning mechanism which also acts as an elevator and discharges the cleaned grit into a barrow in the grit discharge house.

The effluent weir of the grit settling tank is used for measuring and recording the flow receiving primary treatment.

(4) Primary Sedimentation:

From the detritor the flow passes out of the machinery house through a covered channel to the distribution chamber for four circular primary sedimentation tanks 80 ft. in diameter. The distribution is so arranged that flows up to 8 m.g.d. may pass to one pair of tanks only. This allows the other pair to be kept empty ready to receive flows in excess of 8 m.g.d., i.e. storm flows, when these occur. The object of this is, that the flow resulting from small storms of short duration may be very largely, if not entirely held in these storm tanks and little or no discharge of storm water to the river need occur. The contents of these storm tanks are pumped back for full treatment when the rate of flow into the plant has sufficiently diminished. The arrangement is very flexible and the whole flow can be directed to any or all of the tanks at any given time. Two hours detention of 16 m.g.d. is provided, using all four tanks.

The four tanks are identical with centre inlet and peripheral overflow channels discharging by way of a common effluent culvert, located under the influent channel to the

main pump sump in the machinery house. The tanks are substantially flat bottomed and are provided with desludging and skimming mechanisms. Sludge and scum are discharged by way of a common pipe to the sludge pumps in the machinery house.

(5) Aeration Section:

The effluent from the primary sedimentation tanks is raised by the main sewage pumps from the main pump sump and discharged to the aeration section. These pumps are controlled by the level in the sump and will pump a maximum of 8 m.g.d. If the flow exceeds this rate the level in the sump will rise and the excess flow will pass over a weir directly to the effluent outfall pipe and so to the river.

The flow of up to 8 m.g.d. thus pumped for full treatment enters the returned activated sludge re-aeration channel where it is intimately mixed with activated sludge and passes by way of a distribution channel to the aeration tanks which provide five hours retention on 4 m.g.d. flow. The aeration tanks each take the form of a three-pass channel discharging flow to a mixed liquor channel at the opposite end of the aeration plant.

While in the aeration tanks and the distribution and mixed liquor channels, air is introduced to the flow through porous air diffuser domes which are supplied by three air compressors located in the machinery house. Each compressor is capable of delivering 1750 cubic feet per minute of free air at 7 pounds per square inch.

(6) Final Sedimentation:

From the end of the mixed liquor channel, the flow passes to a distribution chamber and thence to two final sedimentation tanks in parallel. These are 80 ft. in diameter and give 2 hours detention on maximum flow of 8 m.g.d. They have centre inlets and peripheral overflows and are fitted with mechanisms which discharge the settled sludge from outlets at the centre of each tank.

From these outlets the settled activated sludge is forced by hydrostatic head through 12" diameter pipes to the activated sludge sump in the machinery house. Here it is raised by two variable speed pumps, a portion being returned to the re-aeration channel for use in the aeration section and the remainder passing to the inlet channel to the primary sedimentation tanks for removal with the primary sludge.

(7) Sludge Digestion:

Sludge from the primary sedimentation tanks, which will also contain the scum from these tanks and the excess activated sludge, is pumped by positive displacement plunger pumps to the sludge digestion tank.

This tank, which has a fixed concrete roof, is 73 ft. in diameter, 26 ft. deep and has a sludge capacity of 100,000 cubic feet. It is divided by a cylindrical partition wall into two compartments in order to provide digestion in two stages. The centre compartment has a capacity of 67,500 cubic feet for first stage or active digestion and the annular compartment which surrounds the first is of 32,500 cubic feet capacity for second

stage, or quiescent digestion and also affords insulation for the first stage compartment which is heated. The partition wall extends from the bottom of the tank to the roof, but has openings above the sludge level so that the gas storage space extends over the whole area of the tank.

Four hot water pipe-coils are located at the centre of the tank and sludge is fed into the tank through the roof between these coils. Compressed digester gas is blown into the bottom of the tank below each coil in order to produce a flow of sludge upward around the heating coils and so ensure uniform heating of the sludge tank contents and an intimate mixing of the raw sludge feed with sludge which is already digesting. Compressed gas may also be blown into the bottom of the first stage compartment at eight other points to assist in thorough agitation and mixing of the whole contents.

A curtain wall is provided connecting the outer wall of the tank to the cylindrical partition wall at one point. On one side of this wall is a port connecting the first stage compartment with the second stage at floor level and on the other side, the digested sludge draw-off pipe passes out through the outer wall of the tank and up to a visual draw-off trough in the control room. The gradual passage of sludge along this channel is assisted by compressed gas which can be blown into the bottom of the tank at 16 points below inclined baffles.

Overflow, sampling and supernatant draw-off pipes pass through the outer wall of the tank from the outlet end of the second compartment into the control room which is located

on the top floor of the digester building. On the lower floor of this building are the gas compressors. Below this is a pipe basement. The boiler fired by sludge gas, is located in the machinery house. Digester overflow and supernatant water gravitates to the primary sedimentation tank effluent pipe and is pumped by the main pumps to the aeration plant.

(8) Sludge Disposal:

The digested sludge is drawn off through the digester control house to the sludge day tank located with the sludge pumping station and sludge storage bed. During normal operation, sludge will be pumped direct from this day tank into tank trucks for disposal on farm land. During the winter or other times when sludge cannot be disposed of on farm land, the digested sludge will flow from the day tank into the sludge storage bed from which it may be pumped at a later date through the day tank. Alternatively, it may be possible to dispose of a portion of the sludge on the remote parts of the site.

OPERATING RESULTS

(1) Loadings and Removals:

Table I indicates the amount of materials dealt with by the plant. The average daily flow per month reached a maximum of 3.49 m.g.d. during April and a low of 1.67 m.g.d. during January. Flows on individual days were much higher than the monthly average of 3.49 m.g.d. and flow rates exceeding 16 m.g.d. were experienced for short periods. However, it was necessary to by-pass the plant for only 2 hours and 55 minutes during the year, due to high flows.

On the average 107.2 tons of BOD and 88.4 tons of suspended solids were removed per month by the plant. Approximately 3.3 cubic feet of grit was removed from the sewage daily.

Graph I indicates the percent removal of BOD and suspended solids due to primary treatment and complete treatment. The BOD reduction during primary treatment was 48 percent or better half the time with the 55 reduction occurring 60 percent of the time. These are very good reductions and result from a rather strong sewage as indicated in Table I, i.e., BOD average of 311 p.p.m. and a suspended solids average of 267 p.p.m.

Complete treatment resulted in a BOD reduction of 93 percent or better half the time and 90 percent or better 85 percent of the time. This represents a high degree of efficiency with respect to BOD removal and results from careful operation. Table I indicates the average BOD in the raw sewage reaching the plant varies from 410 to 210 p.p.m. The plant must therefore cope with a large range of sewage strengths. The range indicated above is based on monthly averages and the actual concentrations will vary considerably more than this from day to day.

The overall reduction in suspended solids was not as good as the BOD reduction. However, it was 85 percent or better one half of the time. The lower efficiency with respect to suspended solids removal results from inflexibility of the aeration section. It is necessary to carry enough activated sludge (living matter) in the aeration section to handle the high concentrations of BOD. As a result during periods of low

concentration there is too much activated sludge and there is a tendency for some of the activated sludge to "die" with a resulting increase in suspended solids in the effluent. However, the resulting suspended solids in the effluent are quite stable (well oxidized) and have a low BOD concentration.

(2) Aeration Section:

Table II indicates the operating performance of the aeration section of the plant. As indicated in the first column in Graph II the primary effluent (or aeration influent) is less in concentration than the raw sewage and does not vary as greatly in strength. However, there is still considerable range in strength that must be dealt with by this section of the treatment plant.

The aeration section is responsible for approximately 50 percent of the BOD removal experienced throughout the plant. A considerable volume of air is required for this removal and it is supplied by three 75 HP air blowers.

Table II indicates that 1350 cubic feet of air were required for each pound BOD removed. The theoretical volume of air required is from 600 to 1000 cubic feet. Since the strength of sewage reaching the aeration section varies in strength, it is necessary to supply air at a rate slightly higher than the theoretical to take care of shock loads. As a result, it is our practice to maintain a dissolved oxygen of from 2 to 3 p.p.m. in the aeration section. Hence, more air than the theoretical amount is used.

(3) Digester and Sludge Disposal:

Table III shows the loading and operating results experienced with the handling of sludge at the plant. A total of 2.99 million gallons of sludge was pumped to the digester during 1961. This mass of sludge is heated to about 90 degrees Fahrenheit and the volatile matter is decomposed at this temperature. The formation of gas (primarily methane) results from this decomposition. This gas is utilized to heat the digester and the buildings at the plant.

The sludge after decomposition is removed from the digester and taken by tank truck to be spread on farm land. The cost of removing 18,301 cubic yards of sludge from the plant during 1961 was \$9,150.50.

Table I
Grit, BOD and SS Removal

Month -----	Flow mgd	Raw BOD(ppm)	Sewage SS(ppm)	Tons BOD Removed	Tons SS Removed	Cu.ft. Grit Removed
Jan.	1.67	375	330	80.8	65.5	167
Feb.	1.86	410	242	132.2	77.1	186
Mar.	3.19	203	210	82.8	74.4	47
Apr.	3.49	225	220	132.0	110.1	24
May	3.27	270	210	118.0	81.6	66
June	2.43	241	240	78.4	74.8	175
July	2.21	310	300	109.0	104.3	105
Aug.	1.87	470	306	121.0	76.9	89
Sept.	2.47	330	330	138.2	122.5	146
Oct.	2.05	375	316	99.0	81.2	113
Nov.	2.73	310	270	102.0	87.8	45
Dec.	<u>2.93</u>	<u>210</u>	<u>230</u>	<u>94.0</u>	<u>102.5</u>	<u>66</u>
<u>TOTAL:</u>				1,287.4	1,058.7	1,229
<u>Average:</u> 2.5		311	267	107.2	88.4	102

Total Flow = 933.41 MG

Grit = 1.32 cu.ft. per MG

BOD = 1.38 tons per MG

S.S. = 1.13 tons per MG

Plant by-passed 2 hours and 55 minutes

Note:

S.S. - suspended solids
BOD - biochemical oxygen demand
mgd - million gallons per day

Table II

Aeration Section

Month	Prim.eff. BOD ppm	MLSS ppm	lbs.BOD per 100 lbs MLSS	1000 lbs BOD Removed	cu.ft.air per lb BOD Removed	cu.ft.air per gal.of Sewage
Jan.	205	2660	15.5	86.5	1,330	2.6
Feb.	195	2480	17.5	119.0	865	1.9
Mar.	108	2405	17.3	83.0	1,110	1.2
Apr.	115	2727	17.8	131.0	805	1.2
May	132	2652	19.6	112.0	988	1.3
June	96	2681	10.5	59.6	1,850	1.9
July	130	2309	15.0	77.4	1,910	2.1
Aug.	195	2163	20.3	96.0	1,400	2.6
Sept.	180	2366	22.6	146.0	1,050	2.2
Oct.	190	2147	21.8	108.5	1,110	2.5
Nov.	120	2647	14.9	68.0	1,640	1.7
Dec.	77	2676	10.2	53.3	2,130	1.3
<u>Total:</u>				1,140.3		
<u>Average:</u> 145		2490	17.8	95.2	1,350	1.9

Note:

1. Prim eff. - Primary Effluent
2. MLSS - Mixed Liquor Suspended Solids
3. Design Loadings - FSIWA Manual of Practice No. 8
 lb BOD/100 lbs MLSS = 20 to 30
 cu.ft. air/10 BOD removed = 600 to 1000
 cu.ft. air/gal = 0.2 to 1.5*

* Sewerage and Sewage Treatment - eighth edition

Table III

Digester Operation and Sludge Disposal

Month ----	Gal.	% Solids	Sludge to Digester lbs.	%Vol.	lbs. Vol. Reduced	%Reo'n of vol.	Gas Prod. cu.ft. (1000)	Sludge hailed cu.yd.
Jan.	192,503	4.9	94,000	72	16,600	25	764.9	410
Feb.	173,811	5.8	101,000	73	18,400	25	643.4	318
Mar.	205,156	6.7	137,000	71	24,800	25	847.9	369
Apr.	289,460	6.0	173,000	73	40,000	40	1,044.6	756
May	298,981	6.1	181,000	73	76,500	58	914.7	1,620
June	303,372	6.0	182,000	66	34,800	29	869.6	2,080
July	354,272	6.0	212,000	72	70,000	46	937.1	3,570
Aug.	246,121	5.6	138,000	73	45,500	45	676.0	1,620
Sept.	349,156	6.6	230,000	68	65,500	42	1,201.1	2,350
Oct.	221,128	5.7	126,000	75	51,000	54	955.5	1,785
Nov.	235,314	5.7	134,000	73	46,000	47	758.0	1,120
Dec.	<u>122,722</u>	<u>5.7</u>	<u>70,000</u>	<u>72</u>	<u>21,200</u>	<u>42</u>	<u>431.6</u>	<u>2,280</u>
Total:	2,991,996		1,776,000		520,300		10,044.2	18,301
Average:	250,000	5.9	148,000	72	42,600	41.5	835.0	

Note:

1. Vol - volatile matter
2. Gas Production Equals 19.1 cu.ft./lb vol.
matter reduced

reduced (normal yield is 15 cu.ft./lb vol.
matter reduced)

OPERATIONS

A great deal of painting was carried out during 1961. The clarifier mechanisms, basement of the machinery building and the detritor room were painted during the year. Some of this work commenced in 1960 but was completed in 1961. The above work was carried out by the operators with the assistance of a casual labourer.

The roadway into the plant receives considerable traffic due to sludge haulage and became badly in need of repair during the past few years. As a result, it was decided at the Local Advisory Committee Meeting in June of 1960 that the city would negotiate the paving of the plant roadway. This too, was completed in 1961 and has greatly improved the plant site.

The city also aided in the building of sidewalks at the plant during the year. The sidewalks aid greatly in the moving of small equipment as well as serving as walkways.

Plant personnel, during 1961, consisted of a chief operator (Mr. K. Stratton) and five operators (Messrs J. Grotts, C. Biggin, W. McManuas, J. Meldrum, and A. MacMillan). Twenty-four hour supervision of the plant was afforded by the above staff. A casual labourer was also employed for much of the year to aid in cutting grass, painting and other duties. In October, Mr. K. Stratton resigned his position at the Stratford S.T.P. to become chief operator of the Lakeview S.T.P. Mr. C. Biggin was appointed acting chief operator of the plant in October. Several persons were interviewed for the position of operator, but no one was selected. As a result, the casual labourer

employed during the summer was retained to lessen the work load on the operators.

Difficulty with the operation of the aeration section was experienced for a short time during early October. It was suspected that a shock load of industrial waste had caused the upset. Unfortunately it is suspected that samples were not obtained early enough to reveal the real source of the problem.

Early in December gas production in the digester fell off rapidly and it was necessary to use fuel oil for heating purposes. Table III indicates the decreased gas production during December. The volatile acids in the digester began to rise (an early indication of problems with digestion) and as a result raw sludge pumpage to the digester was stopped. Samples were collected but they did not reveal definitely the cause of the problem. The city informed the plant staff that a sewer had been cleared of fat and grease during late November and it is quite probable that this material interfered with the digester operation. Approximately $2\frac{1}{2}$ weeks were required to restore the digester to its original operating efficiency.

This problem resulted in a higher than normal fuel expenditure in 1961.

OPERATING COSTS

The 1961 Operating Budget and Expenses:

<u>Item</u>	<u>Forecast 1961</u>	<u>Actual 1961</u>
Payroll	26,210	26,288.77
Fuel	180	1,456.49
Power	5,984	5,813.07
Chemical	100	286.72
General Supplies	1,860	2,879.30
Equipment	734	1,600.21
Repairs & Maintenance	960	359.69
Sundry	12,400	16,331.61
Contingency	<u>1,572</u>	<u>-----</u>
<u>Total:</u>	<u>50,000</u> <u>49,000</u>	55,015.86

Sundry includes sludge haulage which amounted to

\$9,150.50 for 1961.

1961 Operating Deficit

On June 2, 1960, the Local Advisory Committee met at the plant and it was agreed that the painting program contemplated would be taken from the reserve account. It was estimated that this would amount to \$2,000. This work was completed in 1961 at a total cost of \$2,426.42. This money was taken from our operations fund while the work was being completed and we have recommended that it be taken from the reserve account.

During 1961 the small lawnmower at the plant proved inadequate for the amount of grass to be cut at the plant and a

larger lawnmower was purchased. It had been a recommendation of the Local Advisory Committee that the grass cutting be done by the Parks Board on a contract basis. However, the Board did not feel they could afford the time required to cut the grass and as a result, it was necessary to purchase the larger lawnmower and do this work. The cost of the lawnmower was \$562.40 and was not budgeted for in 1961.

The insurance carried on the plant has in the past been paid for at three year intervals. The premium at the Stratford plant was paid during 1961 for three years. The amount spent on insurance was \$3,348.60. In the future, insurance will be paid for at yearly intervals and thus a sudden increase in the budget every three years will be avoided.

The above three items amount to \$6,337.42. We exceeded our 1961 budget estimate by ^{5,015.86}~~\$6,015.86~~. We have taken \$4,653.63 from the reserve account and this will make our actual operating deficit ^{362.23}~~\$1,362.23~~.

The 1962 Operating Estimate

<u>Item</u>	<u>Forecast</u>	<u>% of Total</u>
Payroll	30,500	55.5
Fuel	800	1.5
Power	5,900	10.5
Chemical	480	1.0
General Supplies	3,000	5.5
Equipment	800	1.5
Repairs & Maintenance	800	1.5
Sludge Haulage	9,400	17.0
Sundry	<u>1,300</u>	<u>2.5</u>
Contingency	<u>2,020</u>	<u>3.5</u>
<u>Total:</u>	55,000	100.0

The table below indicates the costs for sewage treatment during 1960 and 1961. There has been an increase in the cost per 1000 gallons due to higher wages and increasing maintenance costs. If the three year insurance premium is proportioned over the next three years, the actual increase in operating costs per 1000 gallons is 0.1 cents.

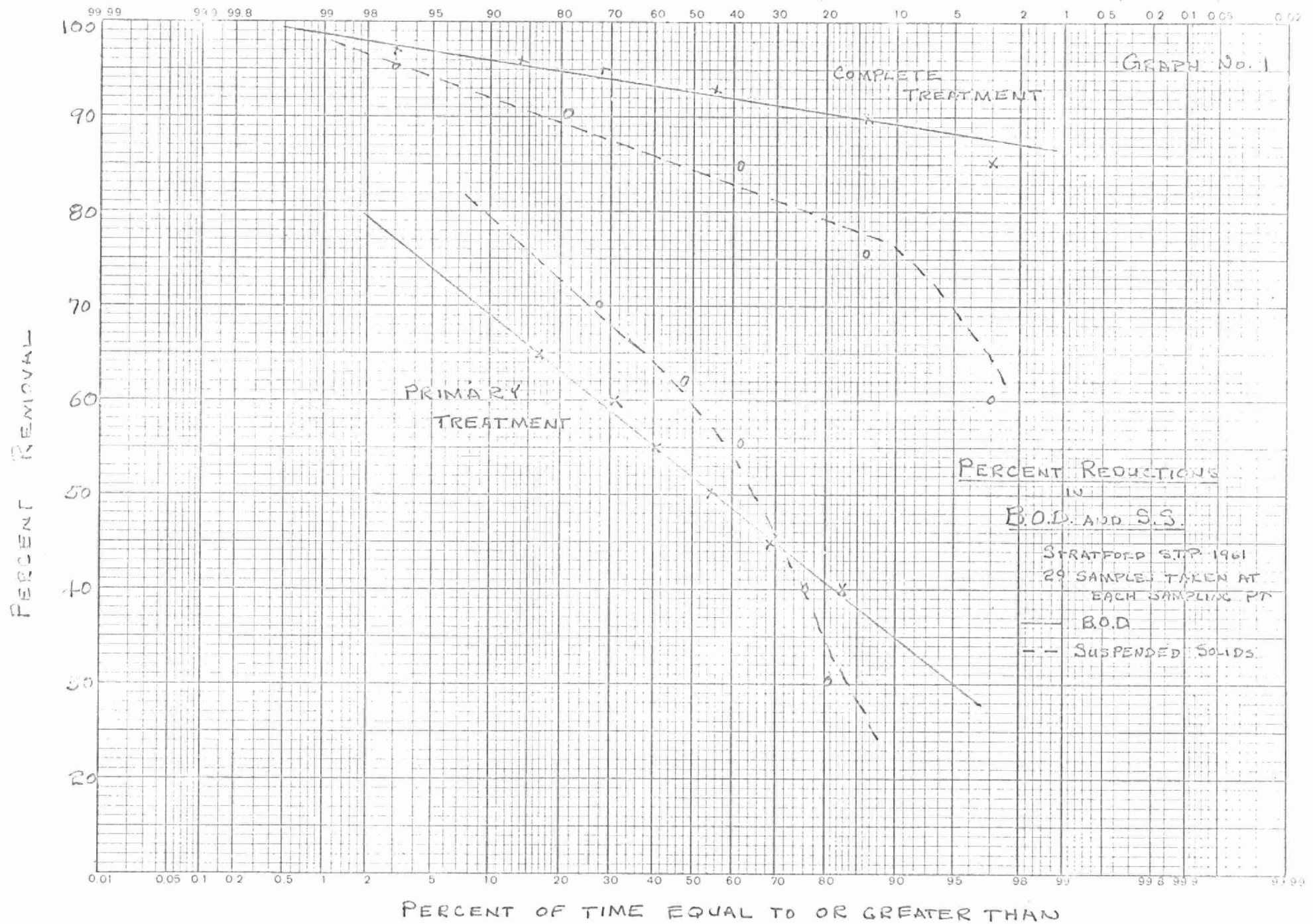
<u>Year</u>	<u>MG treated</u>	<u>Total Cost</u>	<u>Cost/1000 gals.</u>	<u>Cost/capita</u>
1960	932.84	\$51,988.98	5.55¢	\$ 2.57
1961	933.4	55,015.86	5.90	2.69
1961(a)	"	52,783.46	5.65	2.58

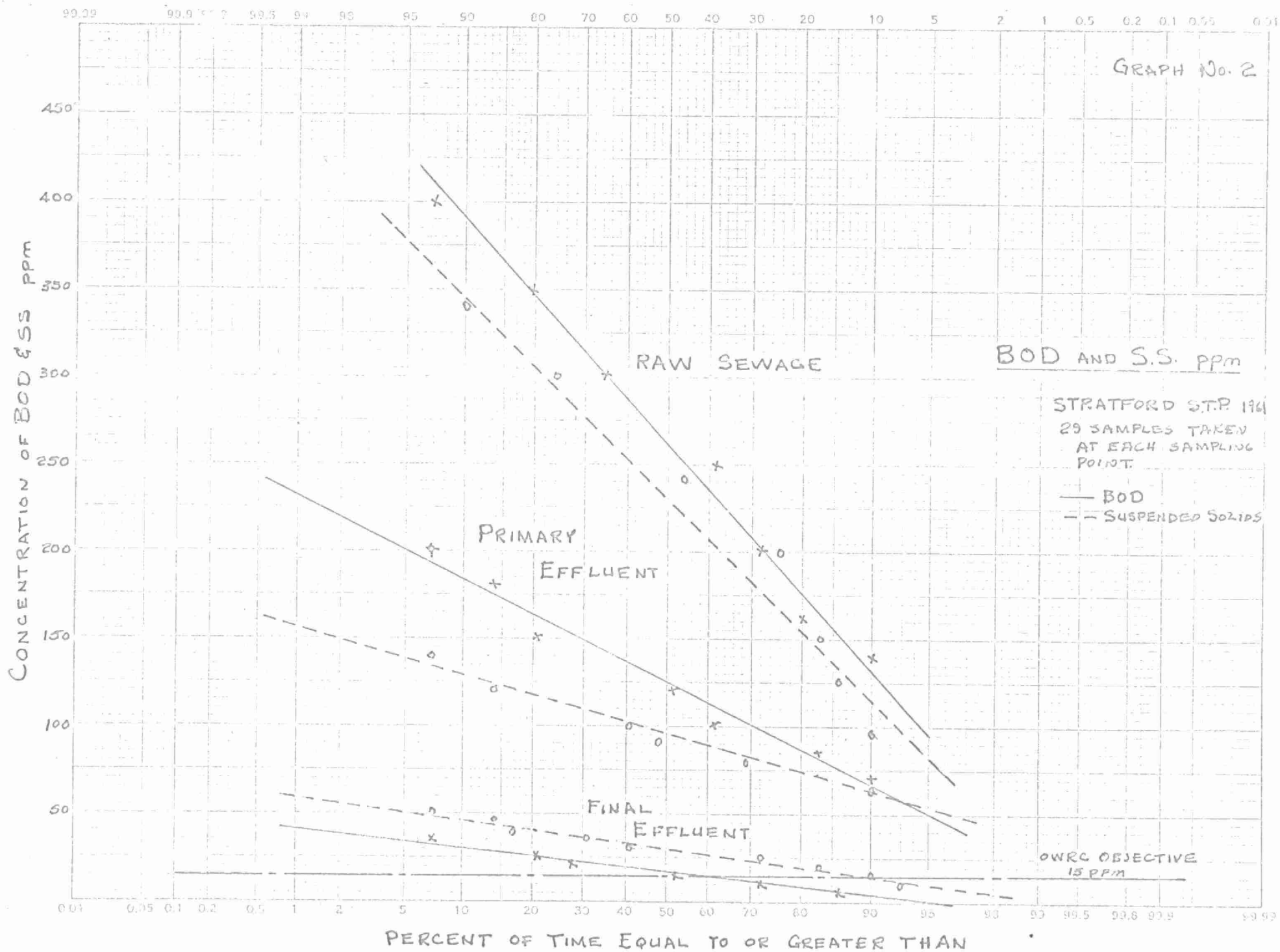
1961 (a) - 2/3 of the insurance premium paid in 1961 for the next 3 years subtracted from the total cost.

MG treated-millions of gallons of sewage receiving complete treatment.

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If the BOD and suspended solids are considered the cost of treating a pound of this material would be 2.14 cents and 2.60 cents respectively.





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